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Results of the 1991 Acoustic Herring Surveys in NAFO Div. 4W, and Revised Results of the 1990 Surveys

by

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ABSTRACT

Survey results for the 1990 and for the 1991 acoustic herring surveys in Chedabucto Bay are presented. The 1990 surveys showed individual nightly abundance estimates of over 350,000 tonnes and an average abundance of about 220,000 tonnes between Jan. 6 and Jan. 8. The abundance dropped to about 39,000 tonnes on Jan. 10, and stayed low until the end of the survey on Jan. 24. The average abundance from Jan. 10 to Jan. 24 was about 19,000 tonnes. This is very strong evidence that the herring left the area around Jan. 10.

During the 1991 surveys, the highest abundance was estimated at 31,000 tonnes during the first night out on Jan. 6. That is about one tenth of the abundance estimated in previous years. This survey evidently did not encounter the major concentrations of herring and it is hypothesized that herring left the bay prior to the survey.

Both the 1990 and the 1991 surveys indicate the critical nature of timing in herring survey work. The herring move into and out of the area and surveys must include the time period of peak abundance.

RÉSUMÉ

Les résultats des relevés acoustiques du hareng réalisés en 1990 et 1991 dans la baie Chédabouctou sont présentés. Un des relevés de 1990 a permis d'estimer une abondance de nuit de plus de 350 000 tonnes, mais la moyenne a été de 220 000 tonnes environ entre le 6 et le 8 janvier. Cette valeur a chuté à 39 000 tonnes environ le 10 janvier et l'abondance est demeurée faible jusqu'à la fin des relevés, le 24 janvier. L'abondance moyenne a été de 19 000 tonnes environ entre le 10 et le 24 janvier. Tout semble indiquer que les harengs ont quitté la biie vers le 10 janvier.

Au cours des relevés de 1991, la plus forte abondance, de 31 000 tonnes, a été estimée au cours de la première nuit, le 6 janvier. Cette valeur correspond au dixième environ de l'abondance estimée au cours des années précédentes. Il est certain que les relevés n'ont pas permis de déceler les plus importantes concentrations de hareng et on suppose que le hareng avait quitté la baie avant que ne soient effectués les relevés.

Les résultats de 1990 et 1991 montrent bien le caractère critique du moment de la réalisation des relevés. Les harengs pénètrent dans la zone mais n'y restent pas de sorte que la période des relevés doit englober celle du pic d'abondance.

INTRODUCTION

The 1991 winter acoustic herring surveys were done with the Alfred Needler (Jan. 5-28, Cruise N147). As in previous years the aim was to do replicate surveys of the 7 x 44 km area along the southern shore of Chedabucto Bay which has become the standard survey index area, and to survey the offshore area SE of Canso. An additional aim this year was to collect dual beam acoustic data and associated biological samples from the cod fishery off Sidney Bight. As in 1990 the Needler could work for only 12-hour periods without a break in inshore waters. To best utilize this time, and because daytime surveys are of questionable value anyway (Buerkle & Stephenson 1991) the surveys in Chedabucto Bay were done only at night.

The results of the 1990 surveys presented to CAFSAC last year were the results of only the first part of the cruise. The remainder of the work was done with an uncalibrated transducer and the results could not be presented. The calibrations have now been done and the 1990 survey results are reevaluated in this paper. Descriptions of survey design and trawl sampling etc. for the 1990 surveys can be found in Buerkle (1990).

1990 SURVEYS

Tables 1 and 2 and Fig. 1 show the results of the 1990 surveys in Chedabucto Bay. Survey N10-11 undertaken during the night of January 10 was the last survey done with the SP302 transducer which was then lost. The remaining surveys starting with survey N12-21 were done with the SP268 replacement transducer. Table 2 shows herring abundance in surveys N12-21 to N24-22 to be about one tenth that of the abundance in surveys N05-11 to N10-11. That, of course, raises very strong suspicions about the performance and the calibration of the transducers.

The SP302 transducer had been calibrated prior to the cruise at the Defence Research calibration barge, and with our Simrad EK50 transmitters, had a source level of 116.8 dB per ubar, and a receive sensitivity of -89.8 dB per ubar. The equivalent ideal beam was 0.0187 sr. The narrow beam of the SP268 transducer was calibrated the same way after the cruise, and showed a source level of 121.1 dB and a receive sensitivity of -80.1 dB. The equivalent ideal beam was 0.00757 sr.

The source levels and receive sensitivities have been verified by measurements on copper calibration spheres, and there is no reason to suspect that the beam pattern measurements made at the calibration barge are in error.

The total effect is, that in a given situation, the SP268 transducer should produce voltages that are 10.7 dB higher than those produced by the SP302 transducer.

The highest scattering observed with transducer SP302 was in transect 40 where the average voltage of all samples of herring echos was 0.179 volts. The highest scattering observed with transducer SP268 was in transect 252 where the average voltage was 0.168 volts. This is 0.6 dB lower than the voltage in transect 40, not 10.7 dB higher.

The highest sample voltage recorded in transect 40 was 0.62 volt; 10.7 dB above that is 2.1 volts. The EK50 tranciever used in the surveys was measured to have a linear relationship of output and input up to output of more than 7 volts. The low output voltages recorded in transect 252, and in all transects done with transducer SP268, can not be attributed to receiver saturation.

Equipment checks, in short, indicate no reasons to discredit the survey results.

1991 SURVEYS

Survey Design

Equidistant parallel line surveys were run during 12 hour periods of darkness in the index area in Chedabucto Bay. Experimentation with transect spacing in the initial surveys, showed that surveys of 20 transects allowed enough time for midwater trawl sampling.

Five replicate surveys were completed from Jan. 5-14. From Jan 14-16 a randomized parallel survey of the area SE of Canso was done. Three more surveys were done in Chedabucto Bay from Jan. 18-21, then the groundfish work off Sidney Bight was done from Jan. 22-24. Two more surveys were done in Chedabucto Bay from Jan. 26-28.

Equipment, Editing and Processing

The survey vessel was the Alfred Needler and the sampling gear was an IGYPT midwater trawl. The acoustic equipment consisted of the SP268 dual beam transducer and towed body used in the second part of the 1990 survey. The echo sounder was a Simrad EK50. Calibration of transducer, tow cable, sliprings and transmitter were done on the Defence Research Establishment barge and verified by measurements on a copper calibration sphere. The calibration parameters were the same as used to process the 1990 survey results.

Acoustic data were recorded on two digital systems, the old single channel Femto model J8618 that has been used since 1987, and the new dual channel Femto model J9001. Calibration of the sounder receiver and the digital systems was done by a new method. The method is simpler than the old method. The procedure is to record output for a number of pings with fixed level input to the receiver. The input level is selected for the output to be within the dynamic range of the receiver over the depth range of interest. For the Simrad EK50 tranceivers the level is 0.0707 volts RMS. The output is processed to adjust the receiver output, at depth, to the ideal time varied gain of $20 \log(R) + .0122(R)$. A big advantage of this method is that calibration data files can be processed as if they were fish data to check that the software does, in fact, calculate the correct estimates of area scattering.

Acoustic data processing was done, as in previous years, only during time periods with herring echos as identified from the echograms. Echograms in these surveys were marked with the times on the J8618 digital system, and edit specifications are thus synchronized to that system. The J9001 runs were started and ended after the J8618 runs because all the buttons could not be pushed simultaneously by the operator.

The results reported here are from the J9001 data because processing the J8618 data showed that system had not recorded properly on many transects. The result is that processed data is a few seconds out of synchronization with the edit data. Missing a few seconds of data at the start of runs, and recording a few seconds more at the end, should not greatly influence the results.

Biological Data

Five midwater tow samples show a herring length/frequency that is similar to the midwater night samples from 1990. There are 4 modal lengths at about 18, 23, 27, and 32 cm, with a mean length of 26.6 cm (Fig. 2). Last year the modes were at about 16, 22 and 27, with a small rise at 30 cm and a mean length of 25.2 cm.

The length/weight relationship calculated this year (M. Power, pers. comm.) was:

$$\text{Weight (kg)} = 6.352\ \text{Length (cm)}^{**}\ 3.0072 * 10E\text{-}06$$

or

$$10 \log \text{Weight(kg)} = 30.07 \log \text{Length (cm)} - 52.0$$

The target strength relationship used to convert to biomass was that of Foote (1987).

$$TS = 20 \log \text{Length (cm)} - 71.9$$

With the length/weight relationship above the target strength per kilogram is :

$$TS\ (kg) = -10.0 \log \text{Length (cm)} - 19.0$$

and the target strength used was -34.4 dB /kg.

Survey Results

Chedabucto Bay survey results are shown by transect in Table 3 and by survey in Table 4 and Fig. 3. The herring appeared to be distributed in a single school, close inshore, as they have been in the last several years. The school appeared to be smaller than in previous years and remained in the same place until the last two nights of the survey (C. Dickson, Cruise Report N147, 6. Feb. 1991).

The most herring encountered were found on the first night out, Jan. 5-6, when the abundance was estimated at 31,000 tonnes. This is about one tenth of the abundance estimated in previous years.

The lowest abundance was estimated from survey N20-21 at 358 tonnes. This survey was repeated covering only the inshore ends of transects at slower speed and going closer to shore. The estimate this time was almost 14 time higher at 4946 tonnes. Most of these fish were found on one transect and there were fish on the inshore end of that. This shows again, that herring near shore can not be properly surveyed, and estimates of abundance can easily be low by several thousand tonnes. It is not likely, however, that more than 90% of a large concentration of herring, like those found in previous years, could be inshore of the survey lines.

DISCUSSION

At first glance, the low herring abundance in the latter half of the 1990 surveys and in the 1991 surveys appears to be related to using the SP268 transducer. There were, however, two very low individual estimates in the first half of the 1990 surveys, and there were low individual estimates in 1989 as well. The difference between the latter half of the 1990 and the 1991 surveys and previous surveys is simply that there were no more high estimates.

The equipment checks, described above, indicate no reasons to discredit the survey results. That raises a question that has been discussed by the CAFSAC Pelagic Subcommittee before, ie. how the Chedabucto Bay estimates relate to the 4WX herring stock size.

The usefulness of the surveys as a time series index of abundance requires that a constant proportion of the stock is present in the survey area during the time of the survey every year. It is becoming more apparent that this is not the case.

In the 1990 surveys it appears that most of the herring left around Jan. 10. Similar events have been reported before. In 1986 the herring were followed out of the bay on Jan. 25 and were observed outside the bay on Jan. 29. In 1987 more than half the herring were outside the bay on Jan. 18, but moved back in on Jan. 20. In 1989 there was a significant decrease of abundance from Jan. 7 to Jan. 23. In 1991 no major concentration of herring was found at all, but we were told by the seiners that there had been lots of herring before Christmas.

In a dynamic situation, where we know little about the timing of the arrival and departure of the fish, it makes little sense to calculate a mean abundance for the time period of the surveys. Such a mean can obviously include estimates made when the herring were not in the area, or indeed, not available for other reasons (Buerkle 1985, 1986). In the 1990 surveys, for example, the overall mean abundance at night was 87,291 tonnes. The mean abundance from Jan. 6-8, when the survey did run into herring, was 258,130 tonnes.

The higher number is a better estimate of the number of herring that visited Chedabucto Bay in January 1990, and should be the number more closely related to stock size.

The original Chedabucto Bay surveys (1984-1987) attempted to map the herring schools and to estimate the maximum number of herring observed. That maximum number was interpreted as the minimum number present in the area. That approach was judged wanting as an abundance index, because there were no estimates of error.

Parallel line surveys now turn out to have a serious problem as well. We can not simply take an average abundance over the time periods of the surveys because the herring may not be present. It is becoming quite clear that another approach to herring surveys and/or to evaluating the survey data is needed. Perhaps a very simple solution like taking the mean of the highest three estimates is possible.

The 1991 survey results suffer from the same timing problem, but in this case no simple solution with data evaluation is possible. A decline of abundance of the herring stock is also indicated by the larval abundance index (Stephenson et al. 1991), but the magnitude of

the decline indicated by the acoustic estimate is quite unrealistic. Judging from the comments by herring seiners it is likely that the major concentrations of herring were present in December, and the January survey missed them. This problem will be addressed in the next survey by surveying in December 1991 and in January 1992.

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TABLE 1.1 Backscatter and biomass for transects.
Chedabucto Bay 1990

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N05_11	2	6458	35.90	-32.0	0.000116	4164	0.1838	6600.133	
N05_11	3	6972	38.76	-32.0	0.000018	698	0.0285	1105.673	
N05_11	4	6610	36.74	-32.0	0.000284	10436	0.4501	16539.275	
N05_11	5	6760	37.58	-34.0	0.000000	0	0.0000	0.000	
N05_11	6	6630	36.86	-34.0	0.000000	0	0.0000	0.000	
N05_11	7	6525	36.27	-34.0	0.000007	254	0.0176	637.786	
N05_11	8	7246	40.28	-34.0	0.000000	0	0.0000	0.000	
N05_11	9	7173	39.87	-34.0	0.000000	0	0.0000	0.000	
D05_11	10	7085	39.39	-34.4	0.000000	0	0.0000	0.000	
D05_11	11	7045	39.16	-34.4	0.000000	0	0.0000	0.000	
D05_11	12	6380	35.47	-34.4	0.001471	52171	4.0515	143691.152	
D05_11	13	7233	40.21	-34.4	0.000000	0	0.0000	0.000	
D05_11	14	6127	34.06	-34.4	0.000000	0	0.0000	0.000	
D05_11	15	6483	36.04	-34.4	0.000000	0	0.0000	0.000	
D05_11	16	6460	35.91	-34.4	0.000000	0	0.0000	0.000	
D05_11	17	5813	32.31	-34.4	0.000000	0	0.0000	0.000	
N06_21	18	5993	33.32	-32.0	0.000045	1499	0.0713	2376.038	
N06_21	20	6554	36.43	-34.0	0.000000	0	0.0000	0.000	
N06_21	22	6476	36.00	-32.0	0.000301	10836	0.4771	17173.943	
N06_21	24	6768	37.62	-34.0	0.000000	0	0.0000	0.000	
N06_21	26	6198	34.45	-34.0	0.000000	0	0.0000	0.000	
N06_21	28	6676	37.11	-34.0	0.003546	131599	8.9071	330561.091	1
N06_21	30	7342	40.81	-34.0	0.000000	0	0.0000	0.000	
N06_21	32	6810	37.86	-34.0	0.000000	0	0.0000	0.000	
N06_22	19	6430	35.74	-32.0	0.000031	1108	0.0491	1756.181	
N06_22	21	5402	30.03	-32.0	0.000136	4084	0.2155	6472.770	
N06_22	23	6275	34.88	-32.0	0.000392	13674	0.6213	21671.874	
N06_22	25	6261	34.80	-34.0	0.000000	0	0.0000	0.000	
N06_22	27	6537	36.34	-34.0	0.001576	57271	3.9587	143857.124	
N06_22	29	6100	33.91	-34.0	0.000000	0	0.0000	0.000	
N06_22	31	6207	34.50	-34.0	0.000000	0	0.0000	0.000	
N06_22	33	7390	41.08	-34.0	0.000000	0	0.0000	0.000	
N07_21	35	6400	35.58	-34.0	0.000000	0	0.0000	0.000	
N07_21	37	7339	40.80	-34.0	0.000000	0	0.0000	0.000	
N07_21	39	6608	36.73	-34.0	0.000295	10836	0.7410	27220.038	
N07_21	41	6757	37.56	-34.0	0.001680	63104	4.2200	158511.171	2
N07_21	43	6147	34.17	-34.0	0.000000	0	0.0000	0.000	
N07_21	45	6297	35.01	-34.0	0.000000	0	0.0000	0.000	
N07_21	47	6529	36.29	-32.0	0.000100	3629	0.1585	5752.324	
N07_21	49	6571	36.53	-32.0	0.000557	20346	0.8828	32246.556	
N07_22	36	7238	40.24	-34.0	0.000000	0	0.0000	0.000	
N07_22	38	6612	36.76	-34.0	0.000000	0	0.0000	0.000	

TABLE 1.2 Backscatter and biomass for transects.
Chedabucto Bay 1990

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N07_22	40	6382	35.48	-34.0	0.003963	140597	9.9546	353164.910	
N07_22	42	6469	35.96	-34.0	0.000000	0	0.0000	0.000	
N07_22	44	5918	32.90	-34.0	0.000000	0	0.0000	0.000	
N07_22	46	6370	35.41	-34.0	0.000000	0	0.0000	0.000	
N07_22	48	6158	34.23	-34.0	0.000000	0	0.0000	0.000	
N07_22	50	5482	30.47	-32.0	0.000030	914	0.0475	1448.962	
D08_11	51	6359	35.35	-34.4	0.000000	0	0.0000	0.000	
D08_11	52	8246	45.84	-34.4	0.000000	0	0.0000	0.000	
D08_11	53	6285	34.94	-34.4	0.000000	0	0.0000	0.000	
D08_11	54	6601	36.69	-34.4	0.000000	0	0.0000	0.000	
D08_11	55	5311	29.52	-34.4	0.000000	0	0.0000	0.000	
D08_11	56	6112	33.98	-34.4	0.004537	154152	12.4959	424569.506	
D08_11	57	6433	35.76	-34.4	0.000000	0	0.0000	0.000	
D08_11	58	6986	38.84	-34.4	0.000000	0	0.0000	0.000	
N08_11	59	7918	44.02	-34.0	0.000000	0	0.0000	0.000	
N08_11	60	7210	40.08	-34.0	0.000000	0	0.0000	0.000	
N08_11	61	6591	36.64	-34.0	0.001633	59832	4.1019	150291.414	
N08_11	62	6612	36.76	-34.0	0.000000	0	0.0000	0.000	
N08_11	63	6392	35.53	-34.0	0.000000	0	0.0000	0.000	
N08_11	64	6120	34.02	-34.0	0.000000	0	0.0000	0.000	
N08_11	65	8204	45.61	-34.0	0.000000	0	0.0000	0.000	
N08_11	66	8374	46.55	-32.0	0.000517	24067	0.8194	38143.468	
D09_21	67	6849	38.07	-34.0	0.000045	1713	0.1130	4303.644	
D09_21	69	6401	35.58	-34.4	0.000000	0	0.0000	0.000	
D09_21	71	5946	33.05	-34.4	0.000000	0	0.0000	0.000	
D09_21	73	6533	36.32	-34.4	0.000000	0	0.0000	0.000	
D09_21	75	6511	36.19	-34.4	0.000000	0	0.0000	0.000	
D09_21	77	6505	36.16	-34.4	0.003844	139004	10.5873	382848.856	
D09_21	81	6720	37.36	-34.4	0.000000	0	0.0000	0.000	
D09_21	83	6892	38.31	-34.4	0.000000	0	0.0000	0.000	
D09_22	68	6917	38.45	-34.0	0.000114	4383	0.2864	11010.811	
D09_22	70	6419	35.68	-34.4	0.000000	0	0.0000	0.000	
D09_22	72	6057	33.67	-34.4	0.000000	0	0.0000	0.000	
D09_22	74	6425	35.72	-34.4	0.000000	0	0.0000	0.000	
D09_22	76	6554	36.43	-34.4	0.000000	0	0.0000	0.000	
D09_22	80	6330	35.19	-34.4	0.005571	196035	15.3438	539925.131	4
D09_22	82	6653	36.98	-34.4	0.000000	0	0.0000	0.000	
D09_22	84	7386	41.06	-34.4	0.000000	0	0.0000	0.000	
N10_11	85	5572	30.97	-34.0	0.000000	0	0.0000	0.000	
N10_11	86	6583	36.59	-34.0	0.000260	9515	0.6531	23899.779	
N10_11	87	6288	34.95	-34.0	0.000000	0	0.0000	0.000	
N10_11	88	6299	35.02	-34.0	0.000000	0	0.0000	0.000	

TABLE 1.3 Backscatter and biomass for transects.
Chedabucto Bay 1990

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N10_11	89	6293	34.98	-34.0	0.000000	0	0.0000	0.000	
N10_11	90	6567	36.51	-34.0	0.000000	0	0.0000	0.000	
N10_11	91	6473	35.98	-32.0	0.000263	9464	0.4168	14998.852	
N10_11	92	7364	40.94	-34.0	0.000000	0	0.0000	0.000	
N12_21	104	7204	35.60	-34.0	0.000000	0	0.0000	0.000	
N12_21	106	6882	34.01	-34.0	0.000000	0	0.0000	0.000	
N12_21	108	5595	27.65	-34.0	0.000000	0	0.0000	0.000	
N12_21	109	954	4.71	-34.0	0.000000	0	0.0000	0.000	
N12_21	112	6646	32.84	-34.0	0.000295	9688	0.7410	24334.728	
N12_21	114	6212	30.70	-34.0	0.000000	0	0.0000	0.000	
N12_21	116	5890	29.10	-34.0	0.000000	0	0.0000	0.000	
N12_21	118	6223	30.75	-34.0	0.000032	984	0.0804	2471.690	
N12_21	120	6567	32.45	-34.0	0.000000	0	0.0000	0.000	
N12_22	105	7263	40.38	-34.0	0.000000	0	0.0000	0.000	
N12_22	107	6761	37.58	-34.0	0.000000	0	0.0000	0.000	
N12_22	110	6448	35.84	-34.0	0.000000	0	0.0000	0.000	
N12_22	113	6460	35.91	-34.0	0.000224	8044	0.5627	20205.854	5
N12_22	115	6120	34.02	-34.0	0.000000	0	0.0000	0.000	
N12_22	117	6187	34.39	-34.0	0.000000	0	0.0000	0.000	
N12_22	119	6452	35.87	-34.0	0.000048	1722	0.1206	4324.464	
N12_22	121	5760	32.02	-34.0	0.000000	0	0.0000	0.000	
D13_11	122	6863	38.15	-34.4	0.000000	0	0.0000	0.000	
D13_11	123	6091	33.86	-34.4	0.000015	508	0.0413	1398.867	
D13_11	124	5870	32.63	-34.4	0.000000	0	0.0000	0.000	
D13_11	125	6066	33.72	-34.4	0.000000	0	0.0000	0.000	
D13_11	126	6524	36.27	-34.4	0.000060	2176	0.1653	5993.243	
D13_11	127	6065	33.72	-34.4	0.000000	0	0.0000	0.000	
D13_11	128	8042	44.71	-34.4	0.000000	0	0.0000	0.000	
D13_11	129	6933	38.54	-34.4	0.000000	0	0.0000	0.000	
D14_11	130	7324	40.71	-34.4	0.000000	0	0.0000	0.000	
D14_11	131	6712	37.31	-34.4	0.000000	0	0.0000	0.000	
D14_11	132	6528	36.29	-34.4	0.000000	0	0.0000	0.000	
D14_11	133	6297	35.01	-34.4	0.000082	2870	0.2258	7905.771	6
D14_11	134	6244	34.71	-34.4	0.000000	0	0.0000	0.000	
D14_11	135	6015	33.44	-34.4	0.000000	0	0.0000	0.000	
D14_11	136	8752	48.65	-34.4	0.000000	0	0.0000	0.000	
D14_11	137	5982	33.25	-34.4	0.000000	0	0.0000	0.000	
N17_21	181	7021	39.03	-34.0	0.000000	0	0.0000	0.000	
N17_21	183	6848	38.07	-34.0	0.000000	0	0.0000	0.000	
N17_21	185	6707	37.28	-34.0	0.000000	0	0.0000	0.000	
N17_21	187	6856	38.11	-34.0	0.000000	0	0.0000	0.000	
N17_21	189	6583	36.59	-34.0	0.000012	439	0.0301	1103.067	

TABLE 1.4 Backscatter and biomass for transects.
Chedabucto Bay 1990

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N17_21	191	6291	34.97	-32.0	0.000014	490	0.0222	775.969	
N17_21	193	6287	34.95	-32.0	0.000012	419	0.0190	664.693	
N17_21	195	6550	36.41	-32.0	0.000000	0	0.0000	0.000	
N17_22	182	7275	40.44	-34.0	0.000000	0	0.0000	0.000	
N17_22	184	6584	36.60	-34.0	0.000000	0	0.0000	0.000	
N17_22	186	6082	33.81	-34.0	0.000000	0	0.0000	0.000	
N17_22	188	6289	34.96	-34.0	0.000096	3356	0.2411	8430.426	7
N17_22	190	5980	33.24	-32.0	0.000003	100	0.0048	158.059	
N17_22	192	6338	35.23	-32.0	0.000007	247	0.0111	390.883	
N17_22	194	6330	35.19	-32.0	0.000003	106	0.0048	167.310	
N17_22	196	5754	31.99	-32.0	0.000000	0	0.0000	0.000	
N20_21	207	7205	40.05	-34.0	0.000000	0	0.0000	0.000	
N20_21	209	7143	39.71	-34.0	0.000000	0	0.0000	0.000	
N20_21	211	6962	38.70	-34.0	0.000000	0	0.0000	0.000	
N20_21	213	5194	28.87	-34.0	0.000009	260	0.0226	652.741	
N20_21	215	6634	36.88	-34.0	0.000099	3651	0.2487	9170.802	18
N20_21	217	6198	34.45	-32.0	0.000011	379	0.0174	600.677	
N20_21	219	6261	34.80	-32.0	0.000006	209	0.0095	330.972	
N20_21	221	6834	37.99	-32.0	0.000004	152	0.0063	240.842	
N20_22	208	8496	47.23	-34.0	0.000000	0	0.0000	0.000	
N20_22	210	6783	37.71	-34.0	0.000000	0	0.0000	0.000	
N20_22	212	6319	35.13	-34.0	0.000000	0	0.0000	0.000	
N20_22	214	6522	36.26	-34.0	0.000180	6526	0.4521	16392.680	
N20_22	216	6387	35.51	-32.0	0.000016	568	0.0254	900.355	
N20_22	218	6032	33.53	-32.0	0.000007	235	0.0111	372.011	
N20_22	220	6442	35.81	-32.0	0.000002	72	0.0032	113.513	
N20_22	222	6343	35.26	-32.0	0.000000	0	0.0000	0.000	
N23_13	243	5913	9.27	-32.0	0.000007	65	0.0111	102.856	
N23_13	244	6373	9.99	-32.0	0.000007	70	0.0111	110.858	
N23_13	245	6250	9.80	-32.0	0.000008	78	0.0127	124.250	
N23_13	246	6376	10.00	-32.0	0.000006	60	0.0095	95.066	
N23_13	247	6235	9.78	-32.0	0.000005	49	0.0079	77.470	
N23_13	248	6218	9.75	-34.0	0.000115	1121	0.2889	2816.264	
N23_13	249	6026	9.45	-34.0	0.000107	1011	0.2688	2539.438	
N23_13	250	6303	9.88	-34.0	0.000156	1542	0.3919	3872.547	
N23_13	251	6241	9.79	-34.0	0.000269	2632	0.6757	6611.975	
N23_13	252	6237	9.78	-34.0	0.000536	5242	1.3464	13166.347	
N23_13	253	6286	9.86	-34.0	0.000094	926	0.2361	2327.164	
N23_13	254	1203	1.89	-34.0	0.000106	200	0.2663	502.223	
N23_13	255	2569	4.03	-34.0	0.000000	0	0.0000	0.000	
N23_21	256	6420	31.72	-32.0	0.000000	0	0.0000	0.000	
N23_21	259	3518	17.38	-32.0	0.000002	35	0.0032	55.102	

TABLE 1.5 Backscatter and biomass for transects.
Chedabucto Bay 1990

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N23_21	260	1433	7.08	-32.0	0.000019	135	0.0301	213.228	
N23_21	262	6409	31.67	-32.0	0.000009	285	0.0143	451.728	
N23_21	264	6447	31.86	-32.0	0.000010	319	0.0158	504.896	
N23_21	266	6488	32.06	-34.0	0.000000	0	0.0000	0.000	
N23_21	268	6171	30.49	-34.0	0.000000	0	0.0000	0.000	
N23_21	270	6821	33.70	-34.0	0.000145	4887	0.3642	12276.094	19
N23_21	272	5831	28.81	-34.0	0.000043	1239	0.1080	3112.115	
N23_22	257	6730	37.41	-32.0	0.000002	75	0.0032	118.588	
N23_22	261	6394	35.54	-32.0	0.000007	249	0.0111	394.337	
N23_22	263	6449	35.85	-32.0	0.000012	430	0.0190	681.821	
N23_22	265	6472	35.98	-34.0	0.000000	0	0.0000	0.000	
N23_22	267	6402	35.59	-34.0	0.000000	0	0.0000	0.000	
N23_22	269	6466	35.94	-34.0	0.000220	7908	0.5526	19863.467	
N23_22	271	6439	35.79	-34.0	0.000121	4331	0.3039	10879.288	20
N23_22	273	7149	39.74	-34.0	0.000000	0	0.0000	0.000	
N24_21	276	7416	41.23	-34.0	0.000002	82	0.0050	207.108	
N24_21	278	6637	36.90	-34.0	0.000089	3284	0.2236	8248.187	
N24_21	280	6273	34.87	-34.0	0.000000	0	0.0000	0.000	
N24_21	282	6480	36.02	-32.0	0.000000	0	0.0000	0.000	
N24_21	284	5841	32.47	-32.0	0.000011	357	0.0174	566.078	
N24_21	286	6200	34.47	-32.0	0.000010	345	0.0158	546.246	
N24_21	288	6416	35.67	-32.0	0.000000	0	0.0000	0.000	
N24_21	290	5805	32.27	-32.0	0.000005	161	0.0079	255.722	
N24_22	277	7362	40.93	-34.0	0.000013	532	0.0327	1336.398	
N24_22	279	6502	36.14	-34.0	0.000080	2892	0.2010	7263.294	
N24_22	281	6158	34.23	-34.0	0.000000	0	0.0000	0.000	
N24_22	283	6697	37.23	-32.0	0.000000	0	0.0000	0.000	
N24_22	285	6544	36.38	-32.0	0.000005	182	0.0079	288.277	
N24_22	287	6158	34.23	-32.0	0.000056	1917	0.0888	3038.256	
N24_22	289	6165	34.27	-32.0	0.000001	34	0.0016	54.316	
N24_22	291	627	3.49	-32.0	0.000055	192	0.0872	303.827	

TABLE 2 Backscatter and biomass for strata.
Chedabucto Bay 1990

Survey	Target Strength (dB/kg)	Stratum Area (km^2)	Area Scattering (sr^{-1})	Total Scattering (m^2/sr) Total	S.E.	Biomass Density (kg/m^2)	Total Biomass (t/stratum) Total	S.E.
N05_11	-32.0	302.27	0.000051	15552	10505	0.0823	24883	16808
D05_11	-34.4	292.55	0.000178	52171	52171	0.4912	143691	143691
N06_21	-33.9	293.61	0.000490	143934	130267	1.1924	350111	328197
N06_22	-33.6	281.30	0.000271	76137	56165	0.6177	173758	141161
N07_21	-33.6	292.67	0.000335	97917	61675	0.7644	223730	153745
N07_22	-34.0	281.45	0.000503	141512	140470	1.2600	354614	352961
D08_11	-34.4	290.92	0.000530	154152	154152	1.4594	424570	424570
N08_11	-33.5	319.20	0.000263	83899	61218	0.5903	188435	149681
D09_21	-34.4	291.05	0.000483	140717	138770	1.3302	387153	382258
D09_22	-34.4	293.19	0.000684	200418	195457	1.8791	550936	538462
N10_11	-33.1	285.95	0.000066	18978	12424	0.1360	38899	26339
N12_21	-34.0	257.80	0.000041	10672	9615	0.1040	26806	24151
N12_22	-34.0	286.02	0.000034	9766	7982	0.0858	24530	20050
D13_11	-34.4	291.59	0.000009	2684	2163	0.0254	7392	5957
D14_11	-34.4	299.37	0.000010	2870	2870	0.0264	7906	7906
N17_21	-32.8	295.42	0.000005	1348	660	0.0086	2544	1288
N17_22	-33.8	281.46	0.000014	3808	3301	0.0325	9147	8337
N20_21	-33.7	291.46	0.000016	4651	3530	0.0377	10996	8941
N20_22	-33.8	296.43	0.000025	7400	6426	0.0600	17779	16219
N23_13	-34.0	113.25	0.000115	12996	5407	0.2856	32346	13638
N23_21	-33.8	244.78	0.000028	6899	4783	0.0679	16613	12104
N23_22	-33.9	291.85	0.000045	12993	8311	0.1094	31938	21005
N24_21	-33.7	283.89	0.000015	4229	3176	0.0346	9823	8050
N24_22	-33.3	256.90	0.000022	5748	3072	0.0478	12284	7178

TABLE 3.1 Backscatter and biomass for transects.
Chedabucto Bay 1991

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N05-06	1	5775	16.05	-34.3	0.000000	0	0.0000	0.000	
N05-06	2	5802	16.13	-34.3	0.000000	0	0.0000	0.000	
N05-06	3	6273	17.44	-34.3	0.000283	4934	0.7617	13280.927	
N05-06	4	6421	17.85	-34.3	0.000361	6443	0.9716	17341.096	
N05-06	5	6276	17.44	-34.3	0.000000	0	0.0000	0.000	
N05-06	6	6164	17.13	-34.3	0.000000	0	0.0000	0.000	
N05-06	7	5906	16.42	-34.3	0.000000	0	0.0000	0.000	
N05-06	8	6281	17.46	-34.3	0.000000	0	0.0000	0.000	
N05-06	9	6125	17.02	-34.3	0.000000	0	0.0000	0.000	
N05-06	10	6146	17.08	-34.3	0.000000	0	0.0000	0.000	1
N05-06	11	5833	16.21	-34.3	0.000000	0	0.0000	0.000	
N05-06	12	6377	17.72	-34.3	0.000000	0	0.0000	0.000	
N05-06	13	6540	18.18	-34.3	0.000000	0	0.0000	0.000	
N05-06	14	6823	18.96	-34.3	0.000000	0	0.0000	0.000	
N05-06	15	7047	19.59	-34.3	0.000000	0	0.0000	0.000	
N05-06	16	7063	19.63	-34.3	0.000000	0	0.0000	0.000	
N06-07	17	5599	10.37	-34.3	0.000000	0	0.0000	0.000	
N06-07	18	7429	13.77	-34.3	0.000000	0	0.0000	0.000	
N06-07	19	7265	13.46	-34.3	0.000000	0	0.0000	0.000	
N06-07	20	7270	13.47	-34.3	0.000000	0	0.0000	0.000	2
N06-07	21	6458	11.97	-34.3	0.000000	0	0.0000	0.000	
N06-07	22	6874	12.74	-34.3	0.000000	0	0.0000	0.000	
N06-07	23	6561	12.16	-34.3	0.000000	0	0.0000	0.000	
N06-07	24	6332	11.73	-34.3	0.000000	0	0.0000	0.000	
N06-07	25	6071	11.25	-34.3	0.000000	0	0.0000	0.000	
N06-07	26	6371	11.81	-34.3	0.000000	0	0.0000	0.000	
N06-07	27	6122	11.34	-34.3	0.000000	0	0.0000	0.000	
N06-07	29	7031	13.03	-34.3	0.000011	143	0.0296	385.732	
N06-07	30	5674	10.51	-34.3	0.000000	0	0.0000	0.000	3
N06-07	31	2718	5.04	-34.3	0.000000	0	0.0000	0.000	
N06-07	32	6608	12.24	-34.3	0.000015	184	0.0404	494.352	
N06-07	33	5832	10.81	-34.3	0.000000	0	0.0000	0.000	
N06-07	34	6145	11.39	-34.3	0.000086	979	0.2315	2635.699	
N06-07	35	6180	11.45	-34.3	0.000103	1180	0.2772	3174.689	
N06-07	36	6266	11.61	-34.3	0.000000	0	0.0000	0.000	
N06-07	37	6181	11.45	-34.3	0.000000	0	0.0000	0.000	
N06-07	38	4050	7.50	-34.3	0.000000	0	0.0000	0.000	
N06-07	39	6889	12.77	-34.3	0.000000	0	0.0000	0.000	
N07-08	40	5878	13.07	-34.3	0.000000	0	0.0000	0.000	4
N07-08	41	6824	15.17	-34.3	0.000000	0	0.0000	0.000	
N07-08	42	6504	14.46	-34.3	0.000000	0	0.0000	0.000	
N07-08	43	6496	14.44	-34.3	0.000000	0	0.0000	0.000	
N07-08	44	5902	13.12	-34.3	0.000000	0	0.0000	0.000	
N07-08	45	6450	14.34	-34.3	0.000032	459	0.0861	1235.283	
N07-08	46	6078	13.52	-34.3	0.000161	2176	0.4333	5856.569	

TABLE 3.2 Backscatter and biomass for transects.
Chedabucto Bay 1991

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N07-08	47	6739	14.98	-34.3	0.000000	0	0.0000	0.000	
N07-08	48	5965	13.26	-34.3	0.000000	0	0.0000	0.000	
N07-08	49	6221	13.83	-34.3	0.000000	0	0.0000	0.000	
N07-08	50	1163	2.59	-34.3	0.000000	0	0.0000	0.000	5
N07-08	51	6204	13.80	-34.3	0.000000	0	0.0000	0.000	
N07-08	52	6278	13.96	-34.3	0.000000	0	0.0000	0.000	
N07-08	53	6224	13.84	-34.3	0.000000	0	0.0000	0.000	
N07-08	54	6593	14.66	-34.3	0.000000	0	0.0000	0.000	
N07-08	55	6598	14.67	-34.3	0.000000	0	0.0000	0.000	
N07-08	56	7310	16.25	-34.3	0.000000	0	0.0000	0.000	
N07-08	57	7288	16.21	-34.3	0.000000	0	0.0000	0.000	
N07-08	58	7238	16.09	-34.3	0.000000	0	0.0000	0.000	
N07-08	59	7323	16.28	-34.3	0.000000	0	0.0000	0.000	
N08-09	60	6314	14.04	-34.3	0.000000	0	0.0000	0.000	
N08-09	61	5529	12.29	-34.3	0.000000	0	0.0000	0.000	
N08-09	62	6732	14.97	-34.3	0.000000	0	0.0000	0.000	
N08-09	63	6599	14.67	-34.3	0.000000	0	0.0000	0.000	
N08-09	64	6315	14.04	-34.3	0.000000	0	0.0000	0.000	
N08-09	65	5870	13.05	-34.3	0.000000	0	0.0000	0.000	
N08-09	66	6020	13.39	-34.3	0.000000	0	0.0000	0.000	
N08-09	67	6996	15.56	-34.3	0.000237	3687	0.6379	9923.270	
N08-09	68	6387	14.20	-34.3	0.000000	0	0.0000	0.000	
N08-09	69	6423	14.28	-34.3	0.000000	0	0.0000	0.000	
N08-09	70	6309	14.03	-34.3	0.000000	0	0.0000	0.000	
N08-09	71	6120	13.61	-34.3	0.000000	0	0.0000	0.000	
N08-09	72	6358	14.14	-34.3	0.000000	0	0.0000	0.000	
N08-09	73	6009	13.36	-34.3	0.000000	0	0.0000	0.000	
N08-09	74	6165	13.71	-34.3	0.000000	0	0.0000	0.000	
N08-09	75	6617	14.71	-34.3	0.000000	0	0.0000	0.000	
N08-09	76	6429	14.30	-34.3	0.000000	0	0.0000	0.000	
N08-09	77	7069	15.72	-34.3	0.000000	0	0.0000	0.000	
N08-09	78	7209	16.03	-34.3	0.000000	0	0.0000	0.000	
N08-09	79	7285	16.20	-34.3	0.000000	0	0.0000	0.000	
N13-14	82	5995	13.33	-34.3	0.000000	0	0.0000	0.000	
N13-14	83	7222	16.06	-34.3	0.000000	0	0.0000	0.000	
N13-14	84	7229	16.07	-34.3	0.000000	0	0.0000	0.000	
N13-14	85	6649	14.78	-34.3	0.000000	0	0.0000	0.000	
N13-14	86	6510	14.48	-34.3	0.000000	0	0.0000	0.000	
N13-14	87	6290	13.99	-34.3	0.000000	0	0.0000	0.000	
N13-14	88	6167	13.71	-34.3	0.000000	0	0.0000	0.000	
N13-14	89	6480	14.41	-34.3	0.000269	3876	0.7240	10432.393	
N13-14	90	6262	13.92	-34.3	0.000000	0	0.0000	0.000	
N13-14	96	6511	14.48	-34.3	0.000000	0	0.0000	0.000	
N13-14	97	6171	13.72	-34.3	0.000000	0	0.0000	0.000	
N13-14	98	6359	14.14	-34.3	0.000000	0	0.0000	0.000	

TABLE 3.3 Backscatter and biomass for transects.
Chedabucto Bay 1991

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N13-14	99	6014	13.37	-34.3	0.000000	0	0.0000	0.000	
N13-14	100	6315	14.04	-34.3	0.000000	0	0.0000	0.000	
N13-14	101	6394	14.22	-34.3	0.000000	0	0.0000	0.000	
N13-14	102	6281	13.97	-34.3	0.000000	0	0.0000	0.000	
N13-14	103	6272	13.95	-34.3	0.000000	0	0.0000	0.000	
N13-14	104	6932	15.41	-34.3	0.000000	0	0.0000	0.000	
N13-14	105	3728	8.29	-34.3	0.000000	0	0.0000	0.000	
N13-14	106	6669	14.83	-34.3	0.000000	0	0.0000	0.000	
N18-19	125	7412	17.35	-34.3	0.000000	0	0.0000	0.000	
N18-19	126	7227	16.92	-34.3	0.000000	0	0.0000	0.000	
N18-19	127	7264	17.00	-34.3	0.000000	0	0.0000	0.000	
N18-19	128	6708	15.70	-34.3	0.000000	0	0.0000	0.000	
N18-19	129	6657	15.58	-34.3	0.000000	0	0.0000	0.000	
N18-19	130	6301	14.75	-34.3	0.000000	0	0.0000	0.000	
N18-19	131	6895	16.14	-34.3	0.000073	1178	0.1965	3170.956	
N18-19	132	6628	15.51	-34.3	0.000127	1970	0.3418	5302.971	
N18-19	133	6416	15.02	-34.3	0.000016	240	0.0431	646.722	
N18-19	135	6956	16.28	-34.3	0.000000	0	0.0000	0.000	
N18-19	136	5989	14.02	-34.3	0.000000	0	0.0000	0.000	
N18-19	137	6206	14.53	-34.3	0.000017	247	0.0458	664.651	
N18-19	138	2128	4.98	-34.3	0.000000	0	0.0000	0.000	
N18-19	139	6403	14.99	-34.3	0.000000	0	0.0000	0.000	
N18-19	140	6327	14.81	-34.3	0.000000	0	0.0000	0.000	
N18-19	141	6359	14.88	-34.3	0.000000	0	0.0000	0.000	
N18-19	142	4617	10.81	-34.3	0.000000	0	0.0000	0.000	
N18-19	143	6483	15.17	-34.3	0.000000	0	0.0000	0.000	
N18-19	144	5916	13.85	-34.3	0.000000	0	0.0000	0.000	
N19-20	145	6503	14.46	-34.3	0.000000	0	0.0000	0.000	
N19-20	146	5668	12.60	-34.3	0.000000	0	0.0000	0.000	
N19-20	147	6547	14.56	-34.3	0.000000	0	0.0000	0.000	
N19-20	148	6556	14.58	-34.3	0.000000	0	0.0000	0.000	
N19-20	149	5979	13.29	-34.3	0.000000	0	0.0000	0.000	
N19-20	150	6407	14.25	-34.3	0.000000	0	0.0000	0.000	
N19-20	151	6173	13.73	-34.3	0.000000	0	0.0000	0.000	
N19-20	152	6189	13.76	-34.3	0.000008	110	0.0215	296.324	
N19-20	153	6321	14.06	-34.3	0.000000	0	0.0000	0.000	
N19-20	154	6036	13.42	-34.3	0.000013	174	0.0350	469.623	
N19-20	155	6685	14.86	-34.3	0.000156	2319	0.4199	6241.409	
N19-20	156	2171	4.83	-34.3	0.000119	574	0.3203	1546.192	
N19-20	158	6469	14.38	-34.3	0.000000	0	0.0000	0.000	
N19-20	159	6273	13.95	-34.3	0.000000	0	0.0000	0.000	
N19-20	160	6426	14.29	-34.3	0.000000	0	0.0000	0.000	
N19-20	161	6700	14.90	-34.3	0.000000	0	0.0000	0.000	
N19-20	162	6812	15.15	-34.3	0.000000	0	0.0000	0.000	
N19-20	163	7241	16.10	-34.3	0.000000	0	0.0000	0.000	

TABLE 3.4 Backscatter and biomass for transects. Chedabucto Bay 1991

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N19-20	164	7228	16.07	-34.3	0.000000	0	0.0000	0.000	
N19-20	165	7273	16.17	-34.3	0.000000	0	0.0000	0.000	
N20-21	169	6468	15.14	-34.3	0.000000	0	0.0000	0.000	
N20-21	171	6727	15.75	-34.3	0.000000	0	0.0000	0.000	
N20-21	172	6464	15.13	-34.3	0.000000	0	0.0000	0.000	
N20-21	173	6418	15.02	-34.3	0.000000	0	0.0000	0.000	
N20-21	174	6509	15.24	-34.3	0.000000	0	0.0000	0.000	
N20-21	175	5936	13.89	-34.3	0.000000	0	0.0000	0.000	
N20-21	176	6728	15.75	-34.3	0.000000	0	0.0000	0.000	
N20-21	177	6224	14.57	-34.3	0.000000	0	0.0000	0.000	
N20-21	178	6131	14.35	-34.3	0.000005	72	0.0135	193.123	
N20-21	179	6524	15.27	-34.3	0.000004	61	0.0108	164.402	
N20-21	180	6410	15.00	-34.3	0.000000	0	0.0000	0.000	
N20-21	181	1987	4.65	-34.3	0.000000	0	0.0000	0.000	
N20-21	182	6164	14.43	-34.3	0.000000	0	0.0000	0.000	
N20-21	183	6506	15.23	-34.3	0.000000	0	0.0000	0.000	
N20-21	184	6135	14.36	-34.3	0.000000	0	0.0000	0.000	
N20-21	185	6504	15.22	-34.3	0.000000	0	0.0000	0.000	
N20-21	186	7195	16.84	-34.3	0.000000	0	0.0000	0.000	
N20-21	187	7122	16.67	-34.3	0.000000	0	0.0000	0.000	
N20-21	188	7010	16.41	-34.3	0.000000	0	0.0000	0.000	
N20-21	169	6468	15.14	-34.3	0.000000	0	0.0000	0.000	
N20-21	171	6727	15.75	-34.3	0.000000	0	0.0000	0.000	
N20-21	172	6464	15.13	-34.3	0.000000	0	0.0000	0.000	
N20-21	173	6418	15.02	-34.3	0.000000	0	0.0000	0.000	
N20-21	174	6509	15.24	-34.3	0.000000	0	0.0000	0.000	
N20-21	175	5936	13.89	-34.3	0.000000	0	0.0000	0.000	
N20-21	176	6728	15.75	-34.3	0.000000	0	0.0000	0.000	
N20-21	177	6224	14.57	-34.3	0.000000	0	0.0000	0.000	
N20-21	178	6131	14.35	-34.3	0.000005	72	0.0135	193.123	
N20-21	184	6135	14.36	-34.3	0.000000	0	0.0000	0.000	
N20-21	185	6504	15.22	-34.3	0.000000	0	0.0000	0.000	
N20-21	186	7195	16.84	-34.3	0.000000	0	0.0000	0.000	
N20-21	187	7122	16.67	-34.3	0.000000	0	0.0000	0.000	
N20-21	188	7010	16.41	-34.3	0.000000	0	0.0000	0.000	
N20-21	189	2221	5.20	-34.3	0.000005	26	0.0135	69.960	
N20-21	190	2416	5.65	-34.3	0.000007	40	0.0188	106.544	
N20-21	191	2178	5.10	-34.3	0.000001	5	0.0027	13.721	
N20-21	192	2390	5.59	-34.3	0.000303	1695	0.8155	4562.192	
N20-21	193	2411	5.64	-34.3	0.000000	0	0.0000	0.000	
N26-27	215	3825	8.51	-34.3	0.000000	0	0.0000	0.000	
N26-27	216	6995	15.55	-34.3	0.000000	0	0.0000	0.000	
N26-27	217	7183	15.97	-34.3	0.000000	0	0.0000	0.000	
N26-27	218	6658	14.80	-34.3	0.000000	0	0.0000	0.000	

TABLE 3.5 Backscatter and biomass for transects.
Chedabucto Bay 1991

Survey	Transect Number	Transect Length (m)	Transect Area (km^2)	Target Strength (dB/kg)	Sa - Area Scattering (sr^{-1})	Total Scattering (m^2/sr)	Biomass Density (kg/m^2)	Total Biomass (t/transect)	Set Number
N26-27	219	6666	14.82	-34.3	0.000246	3646	0.6621	9814.249	
N26-27	220	6276	13.96	-34.3	0.000158	2205	0.4253	5934.672	
N26-27	222	6326	14.07	-34.3	0.000000	0	0.0000	0.000	
N26-27	223	6578	14.63	-34.3	0.000000	0	0.0000	0.000	
N26-27	224	6303	14.02	-34.3	0.000000	0	0.0000	0.000	
N26-27	225	6616	14.71	-34.3	0.000000	0	0.0000	0.000	
N26-27	226	6115	13.60	-34.3	0.000000	0	0.0000	0.000	
N26-27	227	635	1.41	-34.3	0.000000	0	0.0000	0.000	
N26-27	228	6720	14.94	-34.3	0.000000	0	0.0000	0.000	
N26-27	229	6224	13.84	-34.3	0.000000	0	0.0000	0.000	
N26-27	230	6166	13.71	-34.3	0.000000	0	0.0000	0.000	
N26-27	231	6661	14.81	-34.3	0.000000	0	0.0000	0.000	
N26-27	232	6464	14.37	-34.3	0.000000	0	0.0000	0.000	
N26-27	233	6627	14.74	-34.3	0.000000	0	0.0000	0.000	
N26-27	234	6984	15.53	-34.3	0.000000	0	0.0000	0.000	
N26-27	235	13968	31.06	-34.3	0.000000	0	0.0000	0.000	
N27-28	238	7064	15.71	-34.3	0.000000	0	0.0000	0.000	
N27-28	239	7140	15.88	-34.3	0.000000	0	0.0000	0.000	
N27-28	240	7173	15.95	-34.3	0.000000	0	0.0000	0.000	
N27-28	241	6873	15.28	-34.3	0.000000	0	0.0000	0.000	
N27-28	242	6594	14.66	-34.3	0.000125	1833	0.3364	4933.051	
N27-28	243	6598	14.67	-34.3	0.000041	602	0.1104	1619.022	
N27-28	244	6556	14.58	-34.3	0.000062	904	0.1669	2432.693	
N27-28	245	6511	14.48	-34.3	0.000015	217	0.0404	584.515	
N27-28	246	6535	14.53	-34.3	0.000000	0	0.0000	0.000	
N27-28	247	6278	13.96	-34.3	0.000000	0	0.0000	0.000	
N27-28	248	6158	13.69	-34.3	0.000000	0	0.0000	0.000	
N27-28	249	6229	13.85	-34.3	0.000000	0	0.0000	0.000	
N27-28	250	6591	14.66	-34.3	0.000000	0	0.0000	0.000	
N27-28	251	6156	13.69	-34.3	0.000000	0	0.0000	0.000	
N27-28	252	6316	14.04	-34.3	0.000000	0	0.0000	0.000	
N27-28	253	6474	14.40	-34.3	0.000000	0	0.0000	0.000	
N27-28	254	6287	13.98	-34.3	0.000000	0	0.0000	0.000	
N27-28	255	6912	15.37	-34.3	0.000000	0	0.0000	0.000	
N27-28	256	6542	14.55	-34.3	0.000000	0	0.0000	0.000	
N27-28	257	6667	14.82	-34.3	0.000000	0	0.0000	0.000	

TABLE 4 Backscatter and biomass for surveys. Chedabucto Bay 1991

Survey	Target Strength (dB/kg)	Stratum Area (km^2)	Area Scattering (sr^{-1})	Total Scattering (m^2/sr) Total	S.E.	Biomass Density (kg/m^2)	Total Biomass (t/stratum) Total	S.E.
N05-06	-34.3	280.32	0.000041	11377	7850	0.1092	30622	21128
N06-07	-34.3	251.87	0.000010	2486	1492	0.0266	6690	4015
N07-08	-34.3	278.56	0.000009	2635	2200	0.0255	7092	5921
N08-09	-34.3	286.30	0.000013	3687	3687	0.0347	9923	9923
N13-14	-34.3	281.17	0.000014	3876	3876	0.0371	10432	10432
N18-19	-34.3	278.28	0.000013	3636	2226	0.0352	9785	5990
N19-20	-34.3	279.41	0.000011	3178	2350	0.0306	8554	6324
N20-21	-34.3	278.91	0.000000	133	92	0.0013	358	247
N20-21	-34.3	241.52	0.000008	1837	1689	0.0205	4946	4546
N26-27	-34.3	289.05	0.000020	5851	4161	0.0545	15749	11199
N27-28	-34.3	292.75	0.000012	3555	2040	0.0327	9569	5490

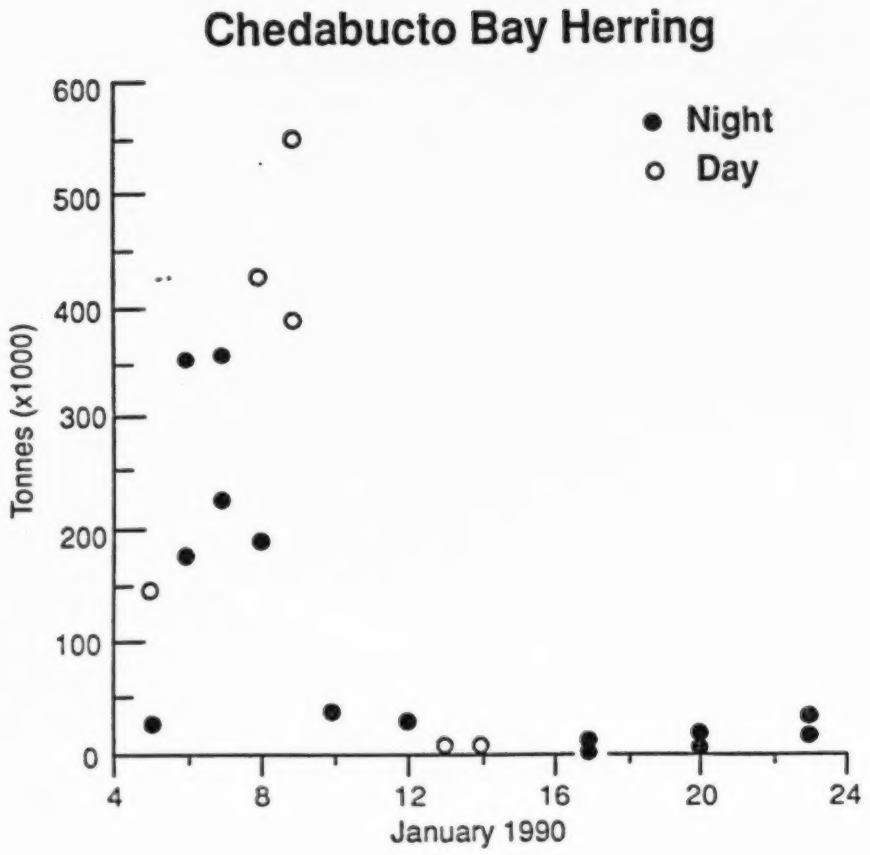
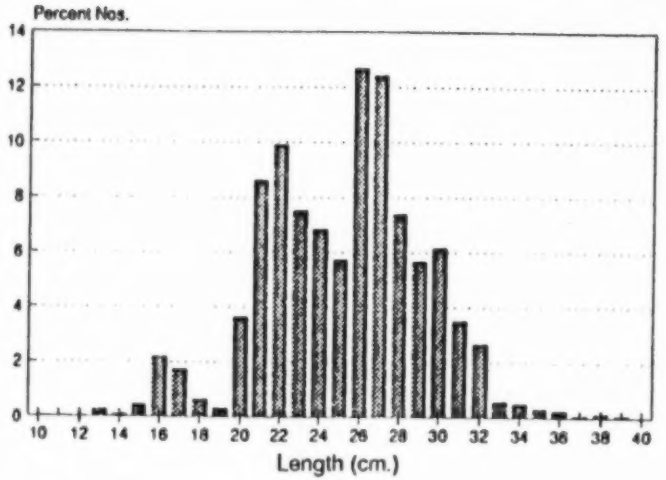


Figure 1. Herring biomass (tonnes) in Chedabucto Bay in January 1990

1990



1991

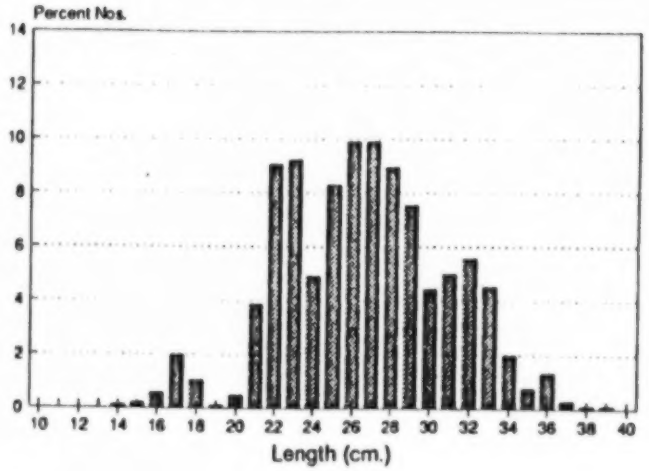


Figure 2. Herring length/frequencies from 1990 and 1991 samples

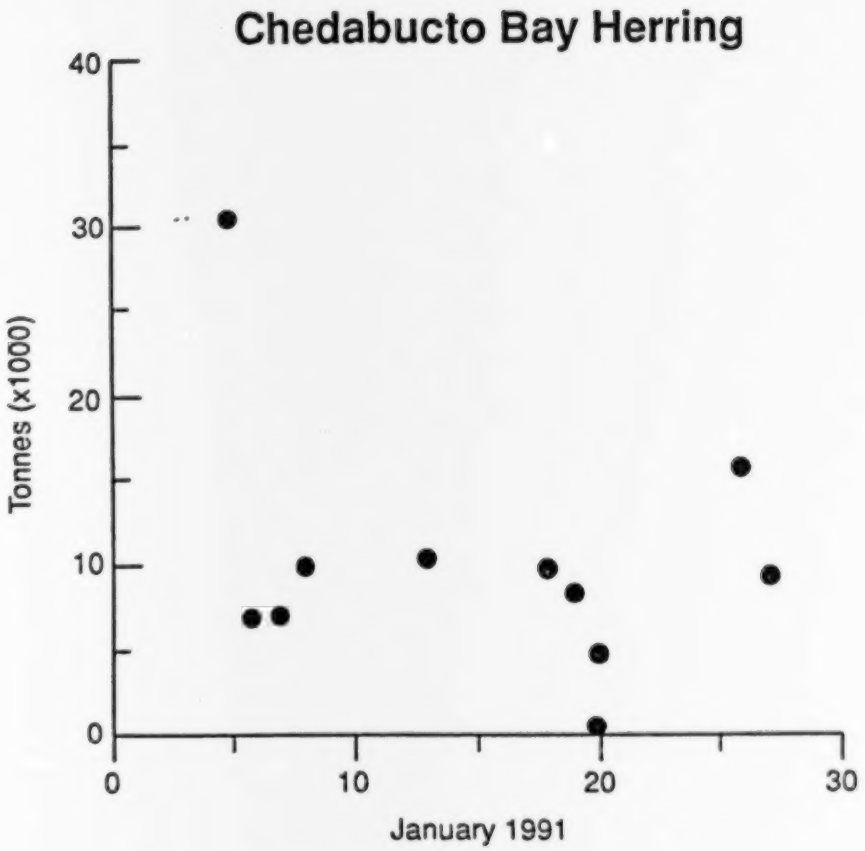


Figure 3. Herring biomass (tonnes) in Chedabucto Bay in January 1991